PROCESS FOR SEALING PLATES IN AN ELECTROCHEMICAL CELL

Detailed Action

1. The amendments filed on November 9, 2009 were received. Applicants have amended claim 38. Claims 1-4 and 27-46 are pending.

Election/Restrictions

2. Applicant's election with traverse of Group I, claims 1-4 and 27-46, in the reply filed on November 9, 2009 is acknowledged. The traversal is on the ground(s) that applicants disagree with the application of the Mercuri reference. This is not found persuasive because applicants have not distinctly and specifically point out the supposed errors in the restriction requirement (i.e., applicants have not proffered any arguments in support of its disagreement with the use of the Mercuri reference as discussed in the election/restriction requirement discussed in the previous Office Action.)

The requirement is still deemed proper and is therefore made FINAL.

Claim Rejections - 35 USC § 112

3. The rejection of claim 38 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention, is maintained.

Claim 38, as amended, recites a "... *the thermoplastic polymer* is a blend of about 1 wt% to about 30 wt% maleic anhydride modified polymer with *the thermoplastic polymer*, partially fluorinated polymers and liquid crystalline polymer or mixtures thereof [emphasis added]." However, claim 37 recites "… a thermoplastic polymer selected from the group consisting of melt processible polymers, partially fluorinated polymers, thermoplastic elastomers, liquid crystalline polymers, polyolefins, polyamides, aromatic condensation polymers, and mixtures thereof." As noted in the previous Office

Action, it appears that Applicant is using a thermoplastic polymer as a group in claim 37 but then is using the term "thermoplastic polymer" as a species in claim 38. Further, how the "partially fluorinated polymers and liquid crystalline polymer or mixtures thereof" are related to the "the thermoplastic polymer" as recited in the claim is unclear.

Claim Rejections - 35 USC § 102

4. The rejection of claims 1, 2, 39, 40, 44, 45 and 46 under 35 U.S.C. 102(b) as being anticipated by Turpin et al. (WO 02/091506 A1) is maintained. The rejection is repeated below for convenience.

Regarding claims 1, 2, 39 and 40, Turpin teaches a flow field plate, with fluid manifolds (flow fields) for fuel cell reactant gases and coolants, having a plurality of protrusions (sealing ridges 7,8,9) that engage with complementary protrusions on an adjacent flow field plate to join and seal it to the adjacent plate via ultrasonic welding (p. 4, 5, 7, 8; Figs. 2, 3). The plates are composed of a polymer with conductive filler (e.g., a thermoplastic with graphite) and carbon nanotubes (p. 5, 6).

Regarding claims 44, 45 and 46, it has been held that, to be entitled to weight in method claims, the recited structure limitations therein must affect the method in a manipulative sense, and not to amount to the mere claiming of a use of a particular structure. *Ex parte Pfeiffer*, 135 USPQ 31 (BPAI 1961). However, Turpin does teach that the protrusions described above are formed near the periphery of the plates as shown in Figs. 2 and 3; and, that the a number of flow fields are formed on the plate (p. 8; Figs. 2, 3).

Claim Rejections - 35 USC § 103

5. The rejection of claims 3, 4 and 27-31 under 35 U.S.C. 103(a) as being unpatentable over Turpin et al. as applied to claims 1, 2, 39, 40, 44, 45 and 46 above, and further in view of Burke (US 4,673,450) and Marianowski (US 6,261,710), is maintained. The rejection is repeated below for convenience.

Turpin is applied and incorporated herein for the reasons above.

Regarding claim 3, Turpin does not expressly teach that the welding step is *resistance* welding (emphasis added).

Burke teaches a method of welding together graphite fiber reinforced thermoplastic laminates that includes placing the two separate pieces to be welded together adjacent each other and applying pressure to the outer sides of the parts (Abstract; 1:50-54). A pair of electrodes is placed on the opposite outer sides of the parts to be welded (1:54-55). A spot weld or weld seam, with good lamination in the weld area, can be accomplished applying voltage in the range of 20 to 40 volts and amperage in the range of 30 to 40 amps using the electrodes for approximately 5 to 10 seconds (1:44-48, 1:55-57, 2:37-45).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use resistance welding to join the flow field plates of Turpin because Marianowski teaches that resistant welding can produce a bond that lowers the contact resistance between joined components, and in turn, promotes better electrical conductivity (see Marianowski, 5:21-23, 6:19-24).

Regarding claims 4 and 31, Turpin teaches (a) placing the mating region and complementary region in close proximity to each other (flow field plate protrusions that engage with complementary protrusions on an adjacent plate to join and seal it to that plate) (p. 4, 5).

However, Turpin does not expressly teach: (b) applying an electrical current between the first coolant plate and the adjacent plate to produce localized heat at the mating region and complementary region sufficient to melt the polymer at the mating region and complementary region; or, (c) ceasing to apply the current and applying pressure to the first coolant plate and the adjacent plate to allow the melted polymer to cool and to create a seal at the mating region and complementary region; or, that the electrical current is applied using external electrodes or the plates themselves.

However, Burke, discussed above, also teaches applying voltage and amperage across electrodes sufficient to soften a thermoplastic material in surface contact between the electrodes; and, cooling those parts in the surface contact area to form a weld (claim 1).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to weld the plates used in the process of Turpin, as modified by Burke, using a resistance welding step to apply the electrical current between the plates with external electrodes that melt the polymer at mating and complementary regions, and to stop the current to allow the melted surfaces to cool and form a seam, because Burke teaches a weld with good lamination in the weld area can be produced.

Regarding claims 27, 28, 29 and 30, Burke teaches applying voltage in the range of 20 to 40 volts and amperage in the range of 30 to 40 amps using electrodes for approximately 5 to 10 seconds when using resistance welding to form a seam between thermoplastic components, as discussed above. Burke also teaches applying pressure to the outer sides of the components in the range of 50 to 100 psi during the welding process (Abstract; 1:50-54, 2:24-28).

It has been held that obviousness exists where the claimed ranges overlap or lie inside ranges disclosed by the prior art. *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990). See MPEP 2144.05 (I). Further, the courts have also held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable range involves only routine skill in the art. *In re Aller*, 105 USPQ 233. See MPEP 2144.05 (11).

Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to apply sufficient current, voltage and pressure during the resistance welding step used in the process of Turpin, as modified by Burke, to adequately join the plates together by creating good lamination in the weld area without damaging those components.

6. The rejection of claims 32-36 under 35 U.S.C. 103(a) as being unpatentable over Turpin et al. as applied to claims 1-4, 27-31, 39, 40, 44, 45 and 46, and further in view of Ledjeff et al. (US 5,733,678) and Scherer (US 3,860,468), is maintained. The rejection is repeated below for convenience.

Turpin is applied and incorporated herein for the reasons above.

Regarding claim 32, Turpin does not expressly teach that the welding step is *vibration* welding (emphasis added)

Ledjeff teaches that the thermoplastic polymer individual components of a fuel cell, such as its current collector and current distributor, are held together by a bonding process, without seals like welding or gluing, employing frictional or high frequency welding (Abstract; 8:39-48, 8:49-9:6).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use vibration welding to join the plates used in the process of Turpin because Ledjeff teaches that vibration welding requires very little to no additional sealing material (see Ledjeff, 5:56-60).

Regarding claims 33 and 34, Turpin teaches (a) placing the mating region and complementary region in close proximity to each other (flow field plate protrusions that engage with complementary protrusions on an adjacent plate to join and seal it to that plate) (p. 4, 5).

Turpin and Ledjeff do not expressly teach: (b) applying a vibrational force between the first coolant plate and the adjacent plate to produce localized heat at the mating region and complementary region sufficient to melt the polymer at the mating region and complementary region; or, (c) ceasing to apply the vibrational force and applying pressure to the first coolant plate and the adjacent plate to allow the melted polymer to cool and to create a seal at the mating region and complementary region; or, that the vibrational force is applied at a frequency of between about 100 and about 500 cycles per second for a time from about 3 to about 100 seconds at an amplitude of between abut 0.5 and about 5 mm.

Scherer teaches a method of friction welding two thermoplastic parts together in predetermined alignment with each other including cyclically moving the parts relative to one another which sets up a relative vibration between the two parts; where opposing forces are substantially equal while pressing the two parts into surface contact with each other for a time sufficient to melt the contacting surfaces by frictionally induced heat; stopping the relative vibration with the parts in predetermined alignment; and, holding the parts in predetermined alignment with the surfaces pressed into contact with each other until the melted thermoplastic resin hardens (Abstract). The friction welding method also includes oscillating the two parts relative to one another through a displacement of small amplitude so that the vibration frequency is about 100 cycles/second and produces a relative movement between the contacting surfaces of between 2 and 8 millimeters during each half cycle of vibration (claim 4).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to apply vibrational force and pressure during the vibration welding step used in the process of Turpin, as modified by Ledjeff, in the manner taught by Scherer, and allow the melted surfaces to cool and form a seam, to form a welded component requiring very little to no sealing material, as discussed above.

As to applying the vibrational force for a time from 3 to about 100 seconds, it would have been obvious to one of ordinary skill in the art to apply the vibration welding step used in the process of Turpin, as modified by Ledjeff and Scherer, for a time sufficient to melt the contacting surfaces of the plates by frictionally induced heat to facilitate the subsequent bonding of those surfaces (see Scherer, Abstract).

Regarding claims 35 and 36, Scherer teaches clamping the parts together to create a pressure at the surfaces to be welded of 15 to 35 kg/cm^2 (i.e., 198 to 412 psig) (Abstract; 3:30-37).

It has been held that obviousness exists where the claimed ranges overlap or lie inside ranges disclosed by the prior art. *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*,

919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990). See MPEP 2144.05 (I). Further, the courts have also held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable range involves only routine skill in the art. *In re Aller*, 105 USPQ 233. See MPEP 2144.05 (11).

Thus, one of ordinary skill in the art at the time of the invention would have found it obvious to apply a force to diffusion layer and separator plate of Davis during the welding process, as taught by Scherer, to urge the mating surfaces of the parts together and promote the melting of the mating surfaces due to the friction set up between the parts (see Scherer, 3:44-47).

7. The rejection of claim 37 under 35 U.S.C. 103(a) as being unpatentable over Turpin et al. as applied to claims 1-4, 27-36, 39, 40, 44, 45 and 46, and further in view of Yamada et al. (JP 2000-017179 A; refer to JPO Abstract and machine translation), is maintained. The rejection is repeated below for convenience.

Turpin is applied and incorporated herein for the reasons above.

Regarding claim 37, Turpin does not expressly teach that the thermoplastic polymer discussed above is selected from the group recited in the claim.

Yamada teaches a conductive resin composition, usable as separator for fuel cell, composed of a (A) liquid crystal polymer, (B) conductive filler (e.g., graphite), and if necessary, (C) carbon fiber or glass fiber, capable of exhibiting excellent moldability, conductivity, gas seal performance and strength (Abstract; machine translation, para. 16, 17, 19). This composition includes preferably 50 to 900 pts. wt, more preferably 100 to 600 pts. wt., of component (B) per 100 pts. wt. of component (A) (Abstract).

It would have been obvious to one of ordinary skill in the art at the time of the invention to use a liquid crystalline polymer when forming the plates of Turpin because Yamada teaches that this polymer facilitates the formation of a fuel cell component exhibiting excellent conductivity and strength.

8. The rejection of claims 41, 42 and 43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Turpin et al. as applied to claims 1-4, 27-37, 39, 40, 44, 45 and 46, and further in view of Davis (GB 2 326 017 A), is maintained. The rejection is repeated below for convenience.

Turpin is applied and incorporated herein for the reasons above.

Regarding claims 41, 42 and 43, Turpin does not expressly teach that the first coolant plate and the adjacent plate includes a polymer rich outer layer on either the mating region, the complementary region, or both; or, that the polymer rich outer layer is between about 25 wt % and about 100 wt % polymer, or about 50 wt % and about 100 wt % polymer.

Davis teaches a fuel cell assembly including thermoplastic bipolar plates, with an electrically conductive filler (e.g., carbon powder or fiber), forming adhesive bonds with other cell components without additional gaskets or seals (Abstract; p. 3, lines 28-30; p. 4, line 31-p. 5, line 3). A thin layer of thermoplastic material with a low melt index may be applied to specific locations on the plate and serve to fuse the plate to an adjacent component under heat and pressure (p. 6, lines 4-20). Further, the layer of thermoplastic material may be rendered conductive by filling it with conductive material (p. 6, lines 25-27). One would appreciate that the thin layer of thermoplastic material can be up to 100 wt % polymer.

It would have been obvious to one of ordinary skill in the art at the time of the invention to use a polymer rich outer layer on at least one of the plates used in the process of Turpin because Davis teaches that it may serve as means with which to join the plates together.

Response to Arguments

9. Applicant's arguments filed November 9, 2009 have been fully considered but they are not persuasive. In sum, applicants argue the that "... Turpin discloses sealing ***flow field plates*** together, … In contrast, the claimed invention seals ***a coolant plate*** to an adjacent plate (another coolant plate or a flow

field plate) … A flow field plate ***is not a coolant plate***, …" (see p. 6 of its remarks). However, as discussed above and repeated here, Turpin teaches a flow field plate, with fluid manifolds (flow fields) for fuel cell reactant gases <u>and coolants</u> [emphasis added], having a plurality of protrusions (sealing ridges 7,8,9) that engage with complementary protrusions on an adjacent flow field plate to join and seal it to the adjacent plate via ultrasonic welding (p. 4, 5, 7, 8; Figs. 2, 3). Further, one of ordinary skill in the art would <u>readily</u> appreciate that a "flow field plate" is used to direct the flow of a number of fluids employed in an electrochemical cell, including those used to cool the cell. Thus, applicants' arguments are unpersuasive.

Conclusion

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Edu E. Enin-Okut** whose telephone number is **571-270-3075**. The examiner can normally be reached on Monday-Thursday, 7 a.m. to 3 p.m. (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Dah-Wei Yuan can be reached on 571-272-1295. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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